Method for displaying digital grey scale images at desired tonal value on a screen of a display device and a display device

The present invention relates to a method for displaying digital grey scale images at a desired tonal value on the screen of a display device. The invention relates also to a display device for implementing the method.

The invention has been conceived particularly for application in relation to medical digital grey scale images, such as e.g. X-ray images, but it is conceivable for other applications as well.

At present, in the process of examining medical digital grey scale images, the shape of a graph relevant to grey scale transformation is adjusted manually for each individual image.

Accordingly, it is an object of the present invention to provide a method and a display device, whereby images examined by an operator can be adjusted automatically to a tonal value desired by the operator. In order to achieve this objective, a method of the invention is characterized in that, in the method, the operator pre-selects manually, for example on the basis of an image visible on a display screen, a grey scale level of his/her desire, the values consistent therewith being stored in a memory associated with a display device, whereby, when the operator picks up a new image for examination, the memory is accessed to retrieve therefrom the information regarding a target grey scale level and relevant to the present operator, said information being used for automatically calculating an individual transformation function relevant to the present new image and the image is automatically adjusted to the operator-specific target grey scale level. A display device of the invention is in turn characterized in that the device comprises means for manually adjusting the grey scale level of an image to a

target grey scale level desired by the operator, memory means for storing therein values relevant to the operator-specific target grey scale level, and computing means for calculating operator-specifically an individual image-specific transformation function for each new image to be examined. The computing means comprise e.g. a microprocessor.

The brightness and contrast of an image are usually controlled manually by separately adjusting brightness and contrast controls, which is time consuming.

Thus, it is a further object of the invention to also provide a method, whereby the brightness and contrast of an image can be controlled in a manner simpler than at present.

In order to achieve this objective, a method according to one preferred further development of the invention is characterized in that, in the method, the brightness of an image adjusts automatically as a result of such a control of contrast that each value of contrast control results in such a selection of the brightness value that as little as possible of the image area is visible in black or white while as much as possible is visible in various tones of grey.

The invention will now be described in more detail with reference to the accompanying drawings, in which:

Fig. 1 shows diagrammatically a few currently employed image histogram transformation functions,

Fig. 2 shows diagrammatically one optimal image histogram transformation function calculable according to the invention,

Fig. 3 shows a flowchart for procedures in a method according to a first aspect of the invention, and

Fig. 4 shows a flowchart for procedures in a method according to a second aspect of the invention.

In figs. 1 and 2, the vertical axis represents the grey scale of a display screen and the horizontal axis represents the grey scale of measured data.

In fig. 1, a graph 10 represents a histogram for an image to be examined, containing a number of grey tones which is multiple with respect to what can be shown on the screen of an ordinary display device (typically a screen is only able to display 256 grey tones while an image histogram may contain thousands of grey tones). In addition, the tonal distribution of an original image can be such that the image is excessively light or dark for the regions of interest to be clearly visible on the display screen.

The image histogram (graph 10) can be subjected to a grey scale / histogram transformation to make the image visually more toned on a display device. One frequently used histogram transformation function comprises an exponential function, having its shape manually adjustable by means of controls. In fig. 1, reference numeral 11 depicts a linear transformation, which does not change the tonal distribution but enables the original image to be shown on a display screen. A graph 12 represents a commonly employed exponential function with fixed parameter values. A graph 13 represents an S-graph with fixed parameter values. Other possible functions include e.g. a logarithmic function, a power-law function, and a square-law function.

In fig. 2, a graph 10 represents a histogram for an image to be examined. The example of fig. 2 is based on a linear transformation indicated by

reference numeral 1. From the graph is calculated a mean grey scale level, and then, for example by using a method of least square, it is compared with an operator-specific target level. On the basis of the comparison, an error 1 is obtained between the graph 1 and the operator-specific target level. This is followed by selecting a desired optimization algorithm, which is used for correcting parametric values of the graph 1, resulting in a graph 2 from which is again calculated a mean grey scale level and an error 2. This goes on for calculating graphs 3 and 4 and further until the error is minimized and is e.g. less than 0,1.

Instead of the mean grey scale level, the comparison can also be done by using other statistical quantities, such as e.g. standard deviation and median, or other functions representing the shape of a histogram.

Fig. 3 is a flowchart depicting the procedures for adjusting images examined by an operator automatically to a tonal value desired by the operator. In a procedure 300, the operator determines a tonal value of his/her desire. A procedure 302 comprises storing values consistent with the target grey scale in a memory associated with a display device. In a procedure 304, the operator picks up a new image for examination on a display device. In a procedure 306, the memory is accessed to retrieve therefrom the information regarding a target grey scale and relevant to the present operator. A procedure 308 comprises a comparison between the target grey scale level and the grey scale level of an image presently on the display device, and a procedure 310 comprises calculating an individual transformation function relevant to the new image and adjusting the image automatically to the target grey scale level.

Fig. 4 is a flowchart depicting the procedures for adjusting an image brightness automatically along with contrast control. A procedure 400 comprises picking up an image for examination on a display device. In a

procedure 402, the image contrast is adjusted manually. A procedure 404 comprises adjusting the image brightness automatically on the basis of contrast, such that as little as possible of the image area is visible in black or white.